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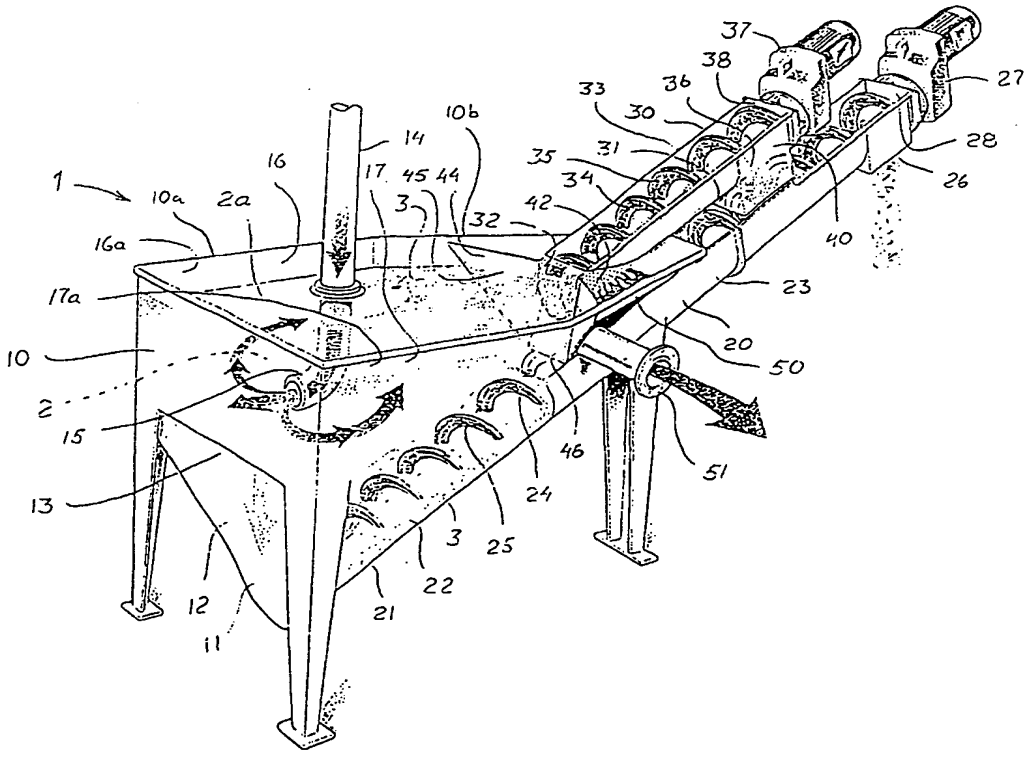
(57) Abstract

The invention relates to a device (1) for separating solid and/or semi-solid substances (3) located in a liquid (2), in which the device includes a container (10), a first sloping screw conveyor (20) and a second sloping screw conveyor (30). The first conveyor has a first portion (22) which forms a channel in the bottom of the container. Bodies of a density exceeding that of the liquid are accumulated in the channel by sedimentation. The first conveyor displaces the accumulated bodies up out of the liquid. The second conveyor (30) has a lower portion (32) located in the liquid (2), in which portion the path of the conveyor is provided with screen openings (42) for the passage of liquid during separation of solid and/or semisolid bodies (3) accompanying the liquid. The second conveyor (30) displaces the separated bodies from the lower portion of the conveyor, at the same time as the screen openings are cleaned. The screen openings discharge in a recepient (50) whose liquid level determines the liquid level in the container (10) and thereby determines the liquid flow through the screen openings.



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SEPARATOR

The present invention relates to a device for separating solid and/or semisolid substances from a liquid, according to the preamble to the independent claims.

In many technical contexts, there is a need for a device which, from a liquid, separates first bodies floating on the liquid, secondly bodies suspended in the liquid, and thirdly bodies which sink down through the liquid and are accumulated towards the bottom of the container holding the liquid.

In industrial operations, for example within with the cellulose industry, the food industry, in purification plants for fresh water or waste water, there are mixtures of liquid, as a rule water and solid or semisolid components (bodies) of different sizes, densities, elasticities, etc. The density of certain bodies is greater than that of the liquid, for certain bodies it is substantially equal to that of the liquid and for certain bodies it is less than that of the liquid. In order to take care of such mixtures, it is necessary to separate the liquid from the substances in order to make for adequate continued treatment of both the liquid and the separated substances.

Liquids occasionally contain substances which cannot be separated using draining devices (screens) or sedimentation. In order to form separable bodies, the liquid is often supplied with polymers, there then being formed bodies which have a density according to one or more of the alternatives disclosed above.

It is obvious that there is a need for a compact and cost-effective device which separates bodies of the above-outlined type out of the liquid.

The above disclosed desiderata are satisfied employing a device according to the characterizing clause of the appended independent claim.

The present invention realizes a device which includes means designed such that they promote the sedimentation of bodies which are present in the liquid and which have a density exceeding that of the liquid, screening devices for separating solid and/or semisolid bodies suspended in the liquid, means for separating bodies floating on the surface of the liquid, and means for upward transport of separated bodies. It will be apparent from the continuation of this description that the above-mentioned functions are wholly or partly realized by one and the same device. Hereby, it is possible to achieve an extremely compact and cost-effective separator arrangement.

The device includes, in one embodiment, conveyors formed from conveyor screws designed as spiral blades lacking mechanical shafts (hereinafter generally referred to as shaftless spirals), and a casing which together form the paths in which the separated bodies are displaced on rotation of the spirals. The casings generally do not surround the spirals (as also applies to the conveyor screws provided with mechanical shaft) but rather form an upwardly open channel. In that part of the path where the casing is provided with drainage openings, the casing generally has a substantially circular cross-section or U-shaped cross-section.

The lack of a mechanical shaft entails that the spirals display slight rigidity transversely of their longitudinal direction as compared with a conveyor screw possessing a mechanical centre shaft. The spirals are designed so as to utilize this movability and are dimensioned so as to allow the spirals to abut against the casings as a result of the influence of force of gravity. On their rotation , the spirals clean the screen surfaces in each respective conveyor and thereby keep the screen drainage openings clear.

The combination of spirals, casings and containers makes for a compact device which realizes efficient separation of the bodies out of the liquid and an efficient transport of the material which is formed from the separated bodies. Since the separated material, once it has been displaced up out of the liquid, is generally surrounded by the casing, the effects on the ambient environment are reduced to a minimum.

Further expedient embodiments of the present invention are disclosed in the appended subclaims.

The present invention and its properties will be more readily perceived on the basis of the following description, with reference to the accompanying drawings, in which:

Fig. 1 is a partly transparent perspective view of the device according to the invention;

Fig. 2 is a side elevation of the device according to the invention;

Fig. 3 is a top plan view of the device according to the invention; and

Fig. 4 is a transverse view of the device according to the present invention.

Referring to the drawings, there is shown a device 1 comprising a container 10 for liquid 2 and provided with a sloping first screw conveyor 20 and a sloping second screw conveyor 30. Each one of the screw conveyors is formed by a screw which is placed in a channel and/or surrounded by a casing. Both of the conveyors have their lowermost portions 22,32 disposed such that they reach down beneath the surface 2a of the liquid. The lowermost portions 22,32 will hereinafter be generally designated the first portion 22 of the first conveyor and the first portion 32 of the second conveyor. The figures show a legged embodiment of the device, an embodiment which makes for simple installation and relocation. It will be obvious to a person skilled in the art that, in other embodiments, the device may be designed as a permanent installation.

As a rule, each one of the conveyor screws 24,34 of the screw conveyors is designed as a shaftless spiral 24,34. This is formed from a spiral blade 25,35 which is generally placed on its edge. The expression spiral blade also encompasses spiral blades composed of a plurality of

part spiral blades which, for example, are disposed to abut radially edge-to-edge against one another or disposed to overlap one another. The spiral has a free central passage which extends in the longitudinal direction at least along a portion of the length of the spiral. For the conveyor screw, use will be made hereafter, without any restrictive import, of the expression shaftless spiral or the word spiral.

The container 10 has, at least in its lower region 12, a substantially conical cross-section. The lowermost portion of the cross-section forms the bottom 11 of the container which is designed so as to form a first sloping path 21 for the first conveyor 20. The bottom forms an upwardly open channel whose cross-section is adapted to accommodate the conveyor screw 24 of the first conveyor which, as a rule, is designed as a shaftless spiral 24. The cross-section is generally U-shaped or forms a part of a circle. In the longitudinal direction of the path, the container is provided with two opposing walls 16,17 which are interconnected to one another by means of an end wall 13.

In the embodiment illustrated in Fig. 1, the container 10 includes a first portion 10a and a second portion 10b. In the first portion, each wall has an upper part 16a, 17a which is substantially vertically oriented. The upper parts of the walls connect to the channel disposed in the lower portion 12 of the container. In the second part, the path has been raised so far that the opposing walls of the container substantially lack vertically oriented portions.

The container 10 is provided with an inlet pipe 14 which is provided with an end portion (bend) 15 directed towards the end 13 of the container. In Fig. 1, reference numeral 3 also relates to solid and/or semisolid bodies which are located in the surface strata of the liquid 2.

The first sloping part 21 continues from the container with a second portion 23 which is located above the maximum permitted liquid surface 2b (cf. Fig. 2). The second portion 23 forms a channel-like path which is generally provided with a safety lid 29. The path and the safety lid together form a casing which surrounds the shaftless spiral. Drive

means 27 for rotating the shaftless spiral is disposed in the region of an upper end 28 of the path 21. In its second portion 23, the path has a discharge opening 26.

The figures show one embodiment of the device in which the second conveyor 30 is disposed above and parallel with the first conveyor 20. The first portion 32 of the second conveyor continues with a second portion 33 which is located above the highest permitted liquid level 2b (cf. Fig. 2) in the container 10. The first and second portions 32,33 also form a channel-like path 31 (hereinafter also referred to as second sloping path 31) which, above the highest permitted liquid level 2b, is generally provided with a safety lid 39. Drive means 37 for rotating the shaftless spiral is disposed in the region of an upper end 38 of the second path 31. A discharge opening 36 is provided in the upper region of the second portion 33 of the second conveyor. As a rule, the discharge opening 36 is, via a drum 40, connected to the second portion 23 of the first conveyor. In embodiments where there is a need for separating sedimented bodies from bodies which have been separated by means of screening devices, the discharge opening 36 is provided with a separate receptacle, e.g. a container.

The first portion 32 of the second conveyor 30 reaches down into the liquid a relatively short distance. In embodiments where it is desired to separate sediment from floating and suspended material, the length of that part of the conveyor which is in contact with the liquid is generally less than the length of approximately four spiral diameters, and preferably the length of three spiral diameters below the lowest level 2c of the liquid surface in which the device is dimensioned to operate. As a rule, the pitch of the screw corresponds to the diameter of the screw. In that part of the conveyor which reaches down into the liquid, and in a region immediately above the liquid, the path of the conveyor forms an upwardly open channel through which the liquid in the container has free access. The length of the open portion of the channel is selected such that the liquid in the container flows into the upwardly open channel without any hindrance as long as the liquid level in the container at most amounts to the predetermined maximum level 2b.

In that part of the first portion 32 of the second conveyor which is in contact with the liquid, the channel is provided with screen openings 42 whose dimensions are adapted so as to prevent substances included in the liquid and exceeding a predetermined size from passing through the openings. Screen openings are also provided in the channel, at least immediately above that part which is in contact with the liquid. A recepiant 50 is provided in the region of the screen openings in order to receive liquid which passes through them. The container 10 and the recepient 50 form two communicating vessels where the container accommodates the mixture of liquid and bodies and the recepiant liquid from which bodies have been separated. The container and the recepiant thus form two discrete and separate storage spaces and the liquid can only pass between them via the screen openings 42.

The recepient 50 is provided with a device 51 for the controlled and drainage of liquid out of the recepiant. As a rule, the device for controlled drainage of liquid is designed as a spillway overflow 51. A pipe provided with a valve is employed when the device is manually supervised. By controlling the quantity of the drained liquid flow, the size of the flow through the screen openings will be determined. This technique thereby makes it possible, by regulating the liquid flow, to avoid liquid flows in the container 10 of a volume or speed which would harmfully effect the sedimentation of bodies. For regulation, use is made of the buffer in liquid quantity whose size is determined by the dimensioned permitteded difference between maximum liquid level 2b and minimum liquid level 2c in the container.

The container 10 is dimensioned, when liquid passes through the screen openings, such that there will not be formed any liquid flows which influence the sedimentation process in the liquid which is located in the portion of the container disposed most distally from the second conveyor 30. This property in the device according to the invention is attained with the above described conical cross-section of the container combined with the upwardly sloping bottom portion of the container, the bottom portion connecting to the path (channel) in which the spiral 24 of the second conveyor is disposed.

In order to avoid sediment from being accumulated beneath the inlet to the second conveyor 30, this is generally provided with a screen 44. The screen is shown in one embodiment (cf. Fig. 1) in which it comprises two substantially vertically oriented walls 45 which sealingly connect to the channel of the second conveyor 30, to the walls of the container 10 and to a steeply sloping bottom plate 46 included in the screen. The bottom plate sealingly connects to the safety lid 29 of the first conveyor 20. The bottom plate slopes more steeply than the safety lid 29. The bottom plate guides sedimented bodies to the first conveyor 20, whereby the bottom plate prevents accumulation of bodies on the safety lid in the region adjacent the inlet to the second conveyor. In the embodiment described in this paragraph, the recepient 50 is defined by the second conveyor 30, the screen 44 and the safety lid 29 of the first conveyor.

Liquid containing material in which are included solid or semisolid components (substances) of different sizes, densities, elasticities, etc is fed into the device via the inlet pipe 14. When the liquid departs from the inlet pipe, the liquid flow from the pipe is directed towards the end wall (short side) 13 of the container. As a result, the short side functions as a distributor which calms the liquid movements in the container.

Material of a density exceeding the density of the liquid is displaced downwards in the liquid and sediments towards the bottom region of the container. On drainage of liquid out of the recepient 50, liquid flows through the screen openings 42. Substances which accompany the liquid remain against the screen openings. On rotation of the second conveyor screw 34, the material retained by the screen openings is moved along the second conveyor and departs therefrom via its discharge opening 36. On rotation of the conveyor screw 24 of the first conveyor, sedimented material is displaced along the first conveyor and departs therefrom via its discharge opening 26.

The device is dimensioned to permit a relatively large difference between maximum liquid level 2b and minimum liquid level 2c (cf. Fig. 2). As a result, the device functions as a buffer which absorbs variations

in the liquid inflow. Emptying of liquid out of the recepiant is thereby adaptable to meet the requirements which must be satisfied for desired sedimentation to have time to take place before liquid containing sedimented bodies passes through the screen openings. In many practical applications, the option is to supply the liquid intermittently through the device, while in other practical applications, use is made of a continuous low flow combined with intermittent emptying of the recepiant.

As will be apparent from the drawing figures, the first container 10 has a continuously reducing cross-section area in a direction towards the second conveyor. This implies that the flow rate is at its greatest in the region most proximal the screen openings, at the same time as the liquid movements in the container most distal from the screen openings 42 are very calm, because of the fact that the cross-sectional area of the container there is much greater than in the region most proximal the screen openings.

The device affords a simple and compact technique for separating bodies out of a liquid, regardless of whether the density of the bodies exceeds, equals or is less than the density of the liquid in which they are located. The device also offers the possibility of separating bodies of high density from bodies of low density.

As a rule, the device is disposed for discontinuous emptying of liquid out of the recepiant, but also offers the possibility of continuously emptying liquid out the recepiant.

The above detailed description has referred to but a limited number of embodiments of the present invention, but a person skilled in the art will readily perceive that the present invention encompasses a large number of embodiments without departing from the scope of the appended claims.

CLAIMS

1. A device (1) for separating solid and/or semisolid substances (3) located in a liquid (2), in which the device includes a container (10) in which the substances are sedimented towards the bottom (11) of the container, and in which a first conveyor (20) is provided for displacing sedimented substances up out of the liquid, c h a r a c t e r i z e d in that a second conveyor (30) including a conveyor screw (34) disposed in a path (31) has a portion (32) located in the liquid (2); that the path in said portion is provided with screen openings (42) for passage of liquid under separation of solid and/or semisolid substances (3) accompanying the liquid; that said second conveyor (30) is disposed to displace separated substances to a discharge opening (36); and that a recepient (50) is provided for receiving liquid which has passed through the screen openings.

2. The device as claimed in Claim 1, c h a r a c t e r i z e d in that the container (10) and the recepient (50) form two separate storage spaces for the liquid; and that the screen openings (42) form the only passages for liquid between the container and the recepiant.

3. The device as claimed in Claim 1 or 2, c h a r a c t e r i z e d in that the recepient (50) is provided with means (51) for the controlled removal of liquid out of the recepiant.

4. The device as claimed in Claim 3, c h a r a c t e r i z e d in that said means for controlled removal of liquid is formed by a spillway overflow (51), for example formed as a pipe provided with a valve.

5. The device as claimed in any of the preceding claims, c h a r r a c t e r i z e d in that the discharge opening (36) of the second conveyor (30) is disposed to emit substances displaced in the conveyor to the first conveyor (20) in a portion (23) thereof located above the maximum permitted liquid surface level (2b) in the container (10).

6. The device as claimed in any of the proceeding claims, c h a r a c t e r i z e d in that the lower portion (12) of the container has a substantially conical cross-section which, at the bottom, for forming a portion (22) of the first conveyor (20) located beneath the liquid surface (2a), forms a sloping path (21) for a conveyor screw (24).

7. The device as claimed in any of the proceeding claims, c h a r r a c t e r i z e d in that at least one of the conveyor screws (24,34) is designed as a shaftless spiral (24,34).

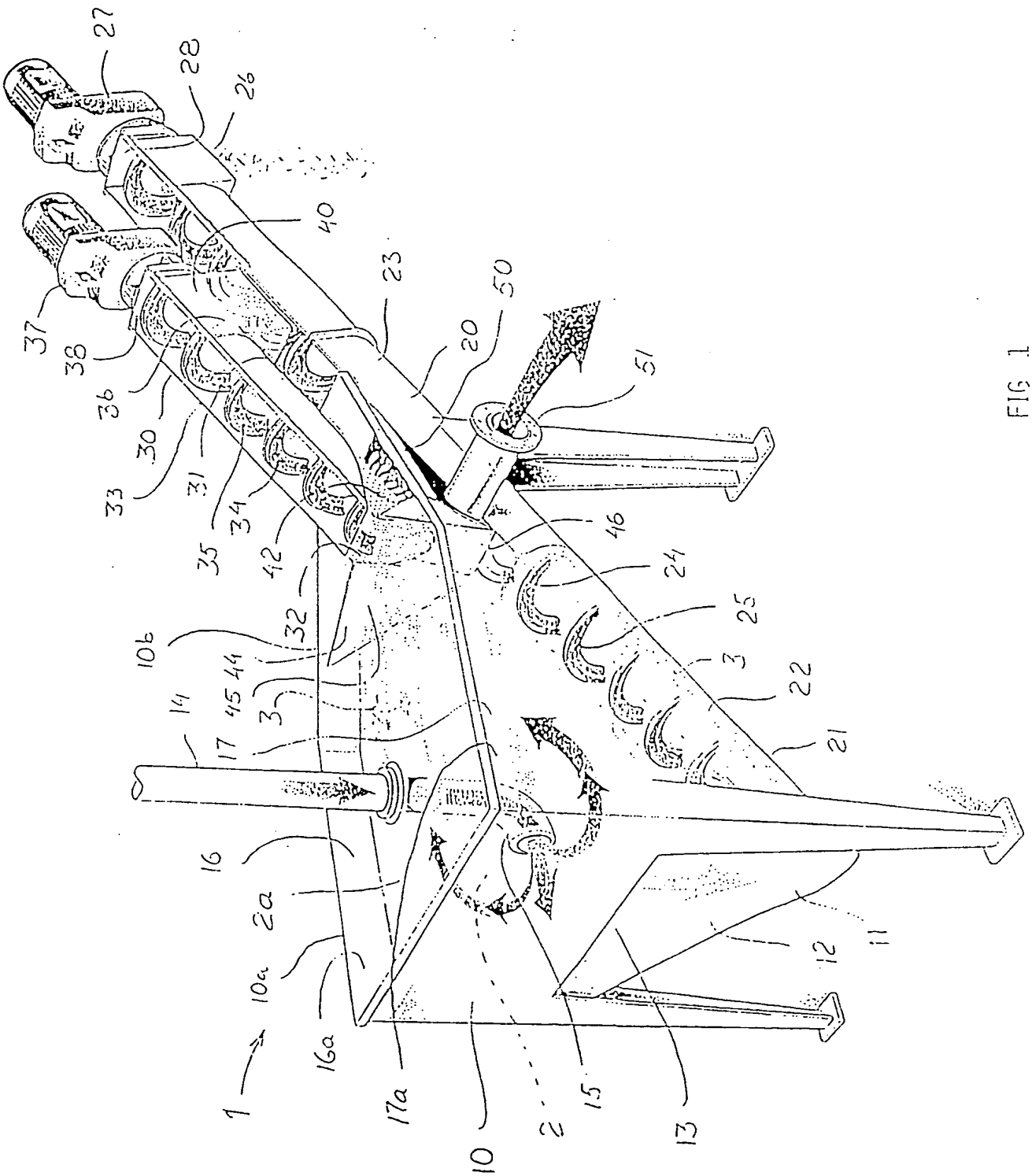
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FIG. 1

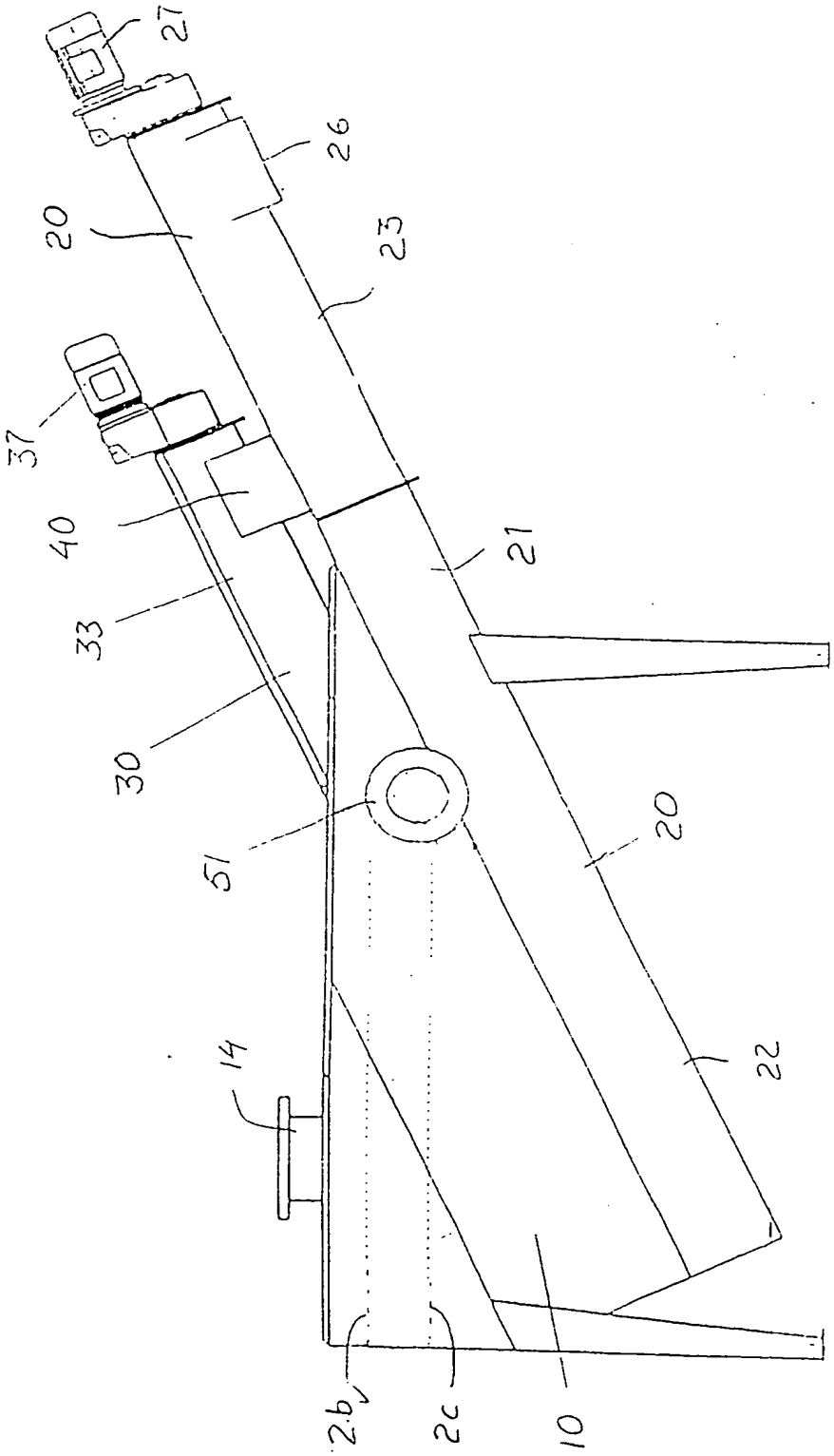

FIG 2

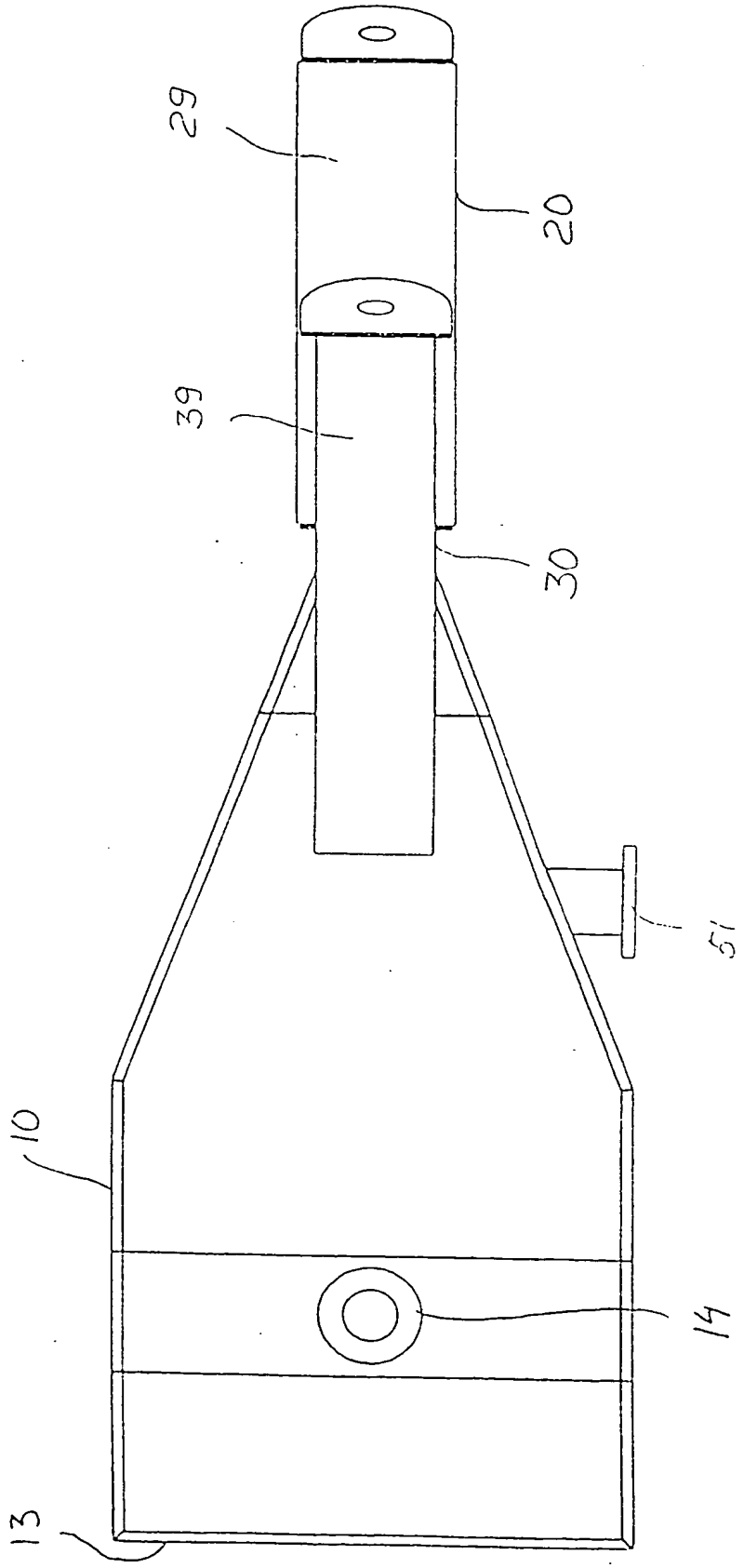

FIG 3

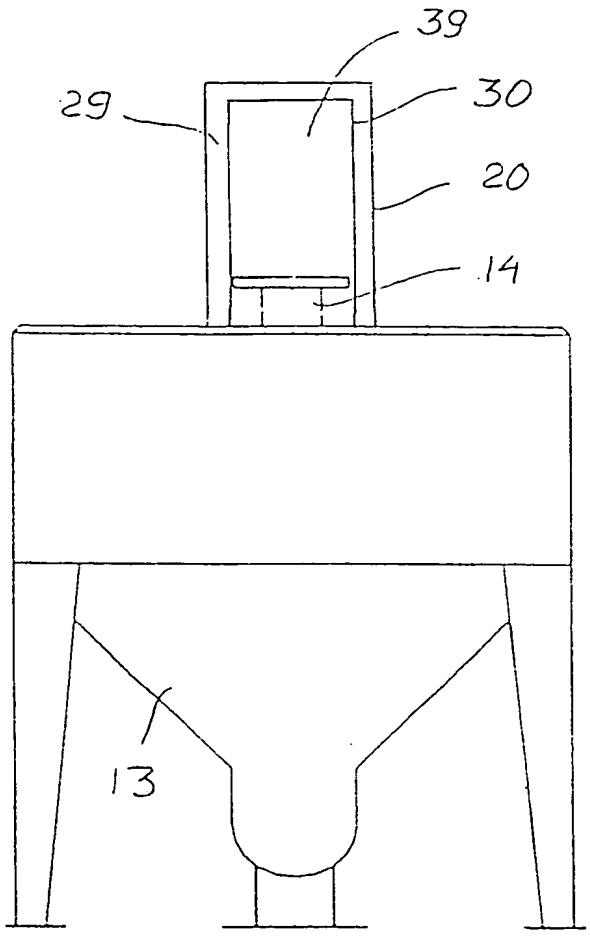

FIG 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 98/00639

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: B01D 21/24, E03F 5/14, B65G 33/12
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

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Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 4143376 A1 (HUBER, HANS GEORG), 29 April 1993 (29.04.93), column 2, line 35 - line 43; column 4, line 44 - line 49; column 5, line 5 - line 10, figure 1	1-7
A	DE 4243171 C1 (HANS HUBER GMBH), 11 May 1994 (11.05.94), column 5, line 1 - line 23	1-7
A	DE 4314673 C1 (HANS HUBER GMBH), 19 May 1994 (19.05.94), column 1, line 15 - line 20	1-7
A	DE 3941673 A1 (HORNBACH KLÄRANLAGEN GMBH & CO KG), 20 June 1991 (20.06.91)	1-7

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INTERNATIONAL SEARCH REPORT

Information on patent family members

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International application No.
PCT/SE 98/00639

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